Herbert Wertheim College of Engineering
UNIVERSITY of FLORIDA

UF-7 Sabretooth

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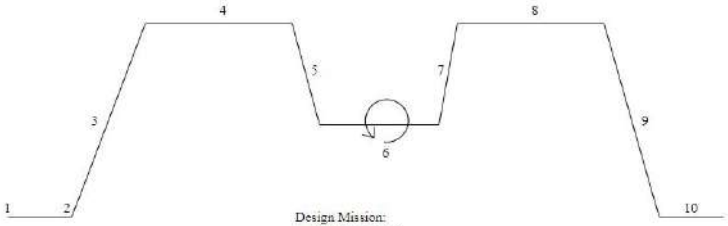
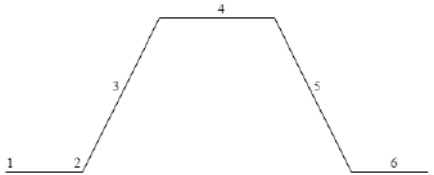
Design Requirements

Type	Requirement
Takeoff	Over a 50ft obstacle, ≤ 4,000ft from austere fields at density altitude up to 6,000ft with semi-prepared runaways with California Bearing Ratio of 5
Landing	Over a 50ft obstacle, ≤ 4,000ft to austere fields at density altitude up to 6,000ft with semi-prepared runaways with California Bearing Ratio of 5
Payload	3,000lbs of armament
Weapons	Integrated gun for ground targets
Service Life	15,000 hours over 25 years
Service Ceiling	≥ 30,000 ft
Crew	Two members, both with zero-zero ejection seats



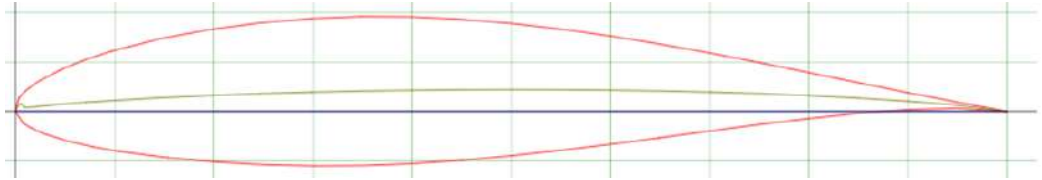
Design Mission:
1 - Warm Up / Taxi
2- Take Off
3 - Climb
4 - Cruise [100 nmi]
5 - Descent [To 3,000 ft within 20 mins]
6 - Loiter [4 hours]
7 - Climb
8 - Cruise [100 nmi]
9 - Descent / Landing
10 - Taxi / Shutdown [5 minutes]



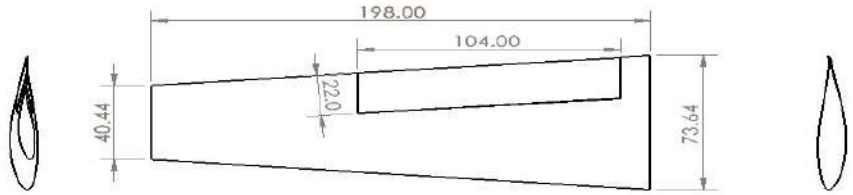
Ferry Mission:
1 - Warm Up / Taxi [5 minutes]
2 - Take Off
3 - Climb
4 - Cruise [900 nmi]
5 - Descent / Landing
6 - Taxi / Shutdown [5 minutes]

Airfoil Design

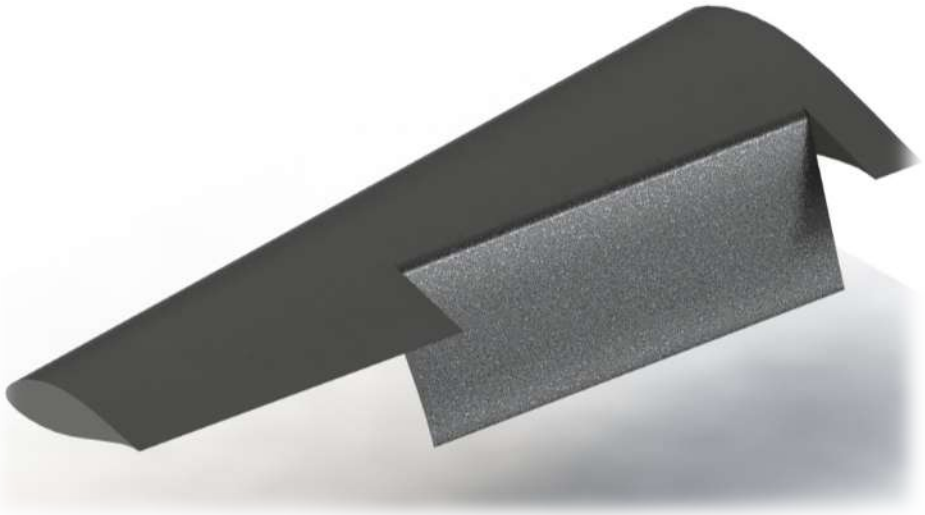
- NACA 63A415
- Cruise Mach Number = 0.42
- $C_{l_{max}} = 1.5$
- $C_l \; at \; \alpha = 0°: 0.40$



Wing Design

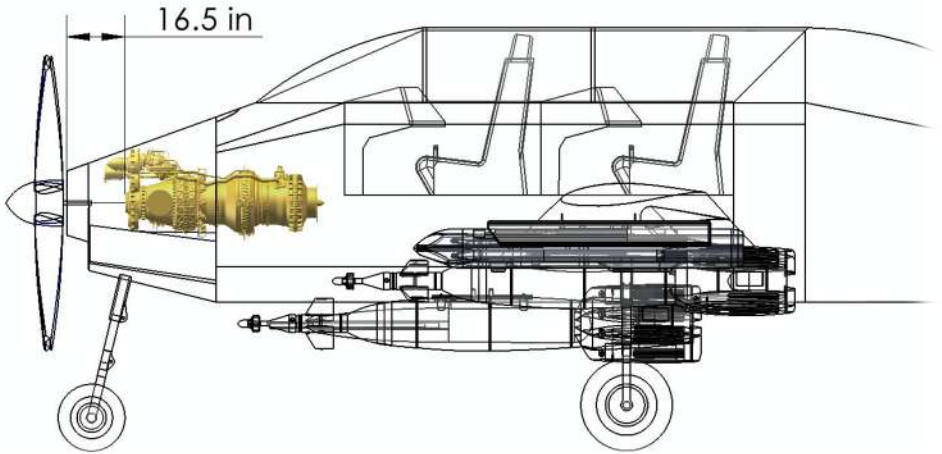


- Plain Flap
- Cut-off Wing Tips
- Wing Span: 34.9 ft
- Wing Area: 156.9 ft^2
- Wing Sweep: 3°
- Taper Ratio: 0.55
- Chord at Root: 6.13 ft
- Wing Twist: -3°
- Dihedral: 5°
- Aspect Ratio: 6.945

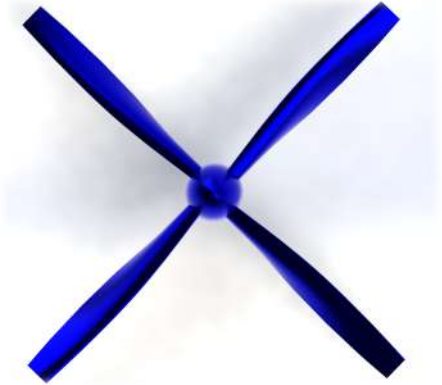


Propulsion – Engine

- Required SHP: 1500 SHP
  - Takeoff thrust-to-weight: 0.1313
  - Takeoff Weight: 10,959 lbs
- PT6A-68D: 1600 SHP
  - Single engine in front of cockpit
  - Weight: 272 lbs
  - Diameter: 19 in
  - Length: 62 in
  - Specific fuel consumption: 0.67 $\frac{lbs}{hph}$



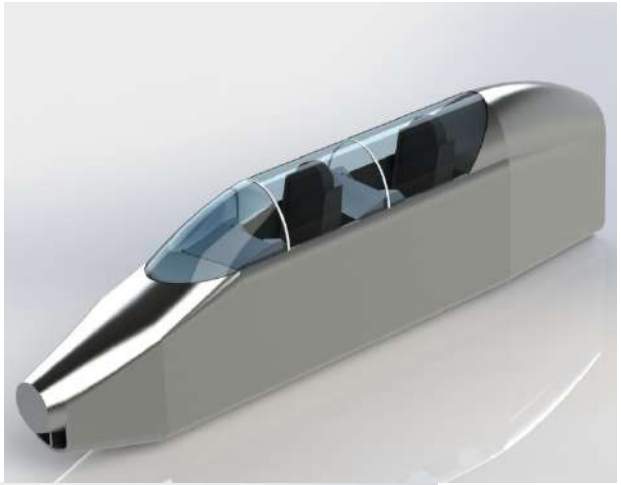
Propulsion – Propeller

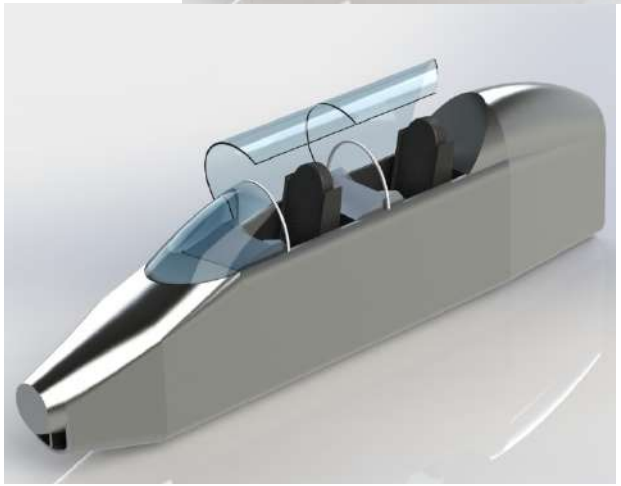


- Diameter: 9.468 ft
- Power: 880,000 hp
- Thrust: 1398 lbs
- RPM:
  - 1190 RPM (70%)
  - 1700 RPM (100%)

Fuselage & Crew

- Fuselage:
  - Length: 33.6 feet
  - Diameter: 4.2 feet
- Crew station:
  - Martin-Baker Mk16-US16LA ejection seats
  - Length: 145 in
  - Look down angle: 40.2 degrees



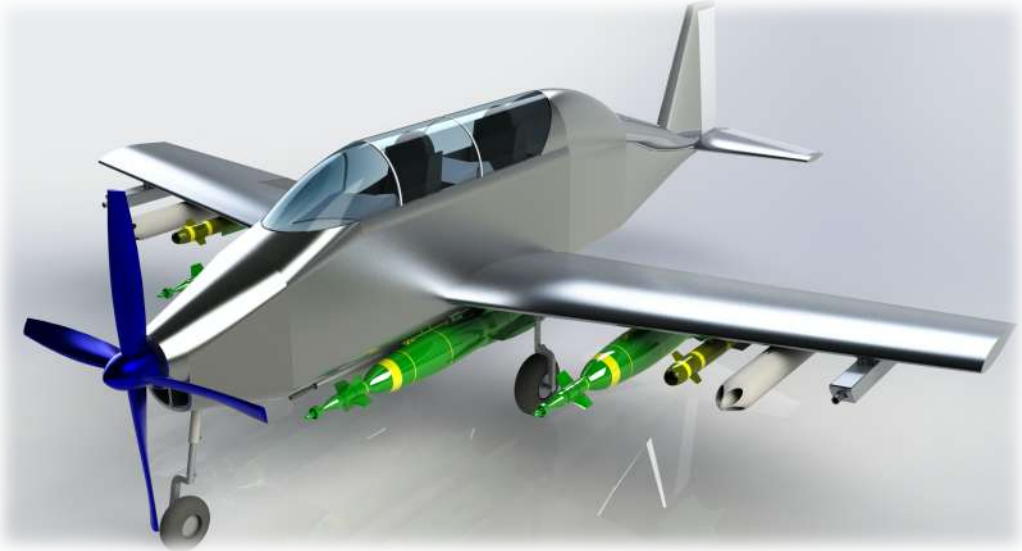


Tail Design

- Horizontal tail:
  - Leading edge sweep: 8°
  - Aspect ratio: 3
  - Taper ratio: 0.4
  - Area: 26.61 ft^2
  - Span: 9.65 ft
  - Root chord: 3.94 ft
- Vertical tail:
  - Sweep: 25°
  - Aspect ratio: 1
  - Taper ratio: 0.4
  - Area: 10.28 ft^2
  - Span: 3.79 ft
  - Root chord: 3.87 ft

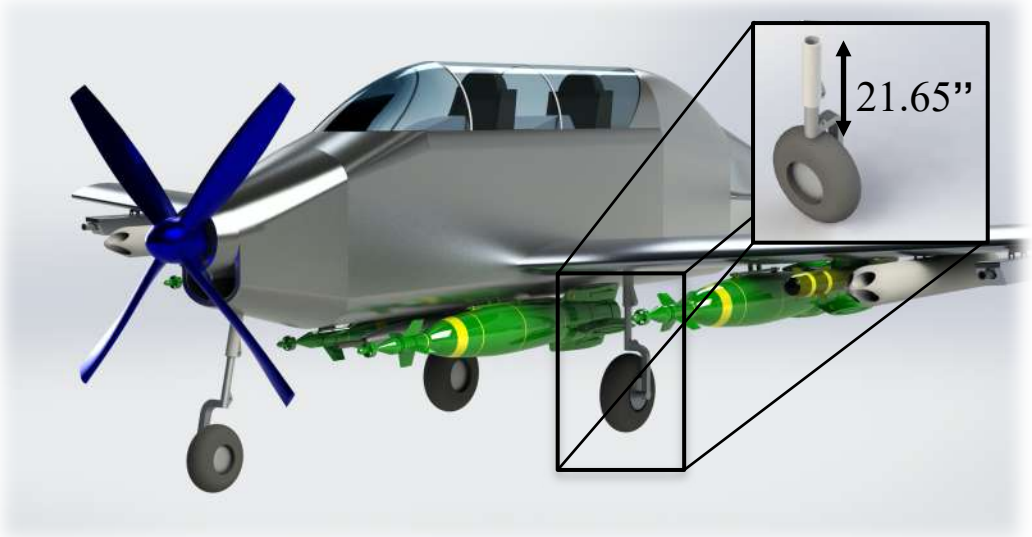
Landing Gear

- Retractable
  - Reduce drag, radar signature
  - Retract into wing
- Tricycle configuration
  - Best for austere fields
- Oleo Shocks used to support weight of aircraft

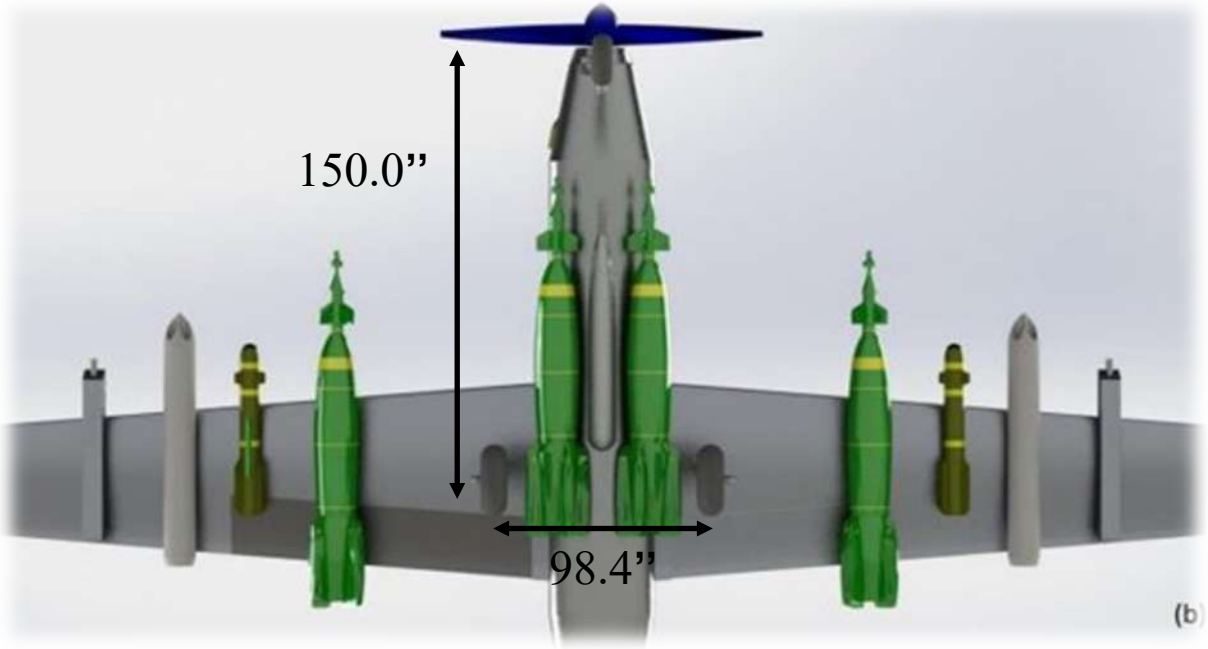


Landing Gear

- Main Gear
  - Support ~90% of vehicle weight
  - Use Goodyear 8.50-10 tires
  - Oleo Shock: 21.65 in length, 2.4 in diameter
- Nose gear
  - Goodyear 7.00-6 tire



Landing Gear

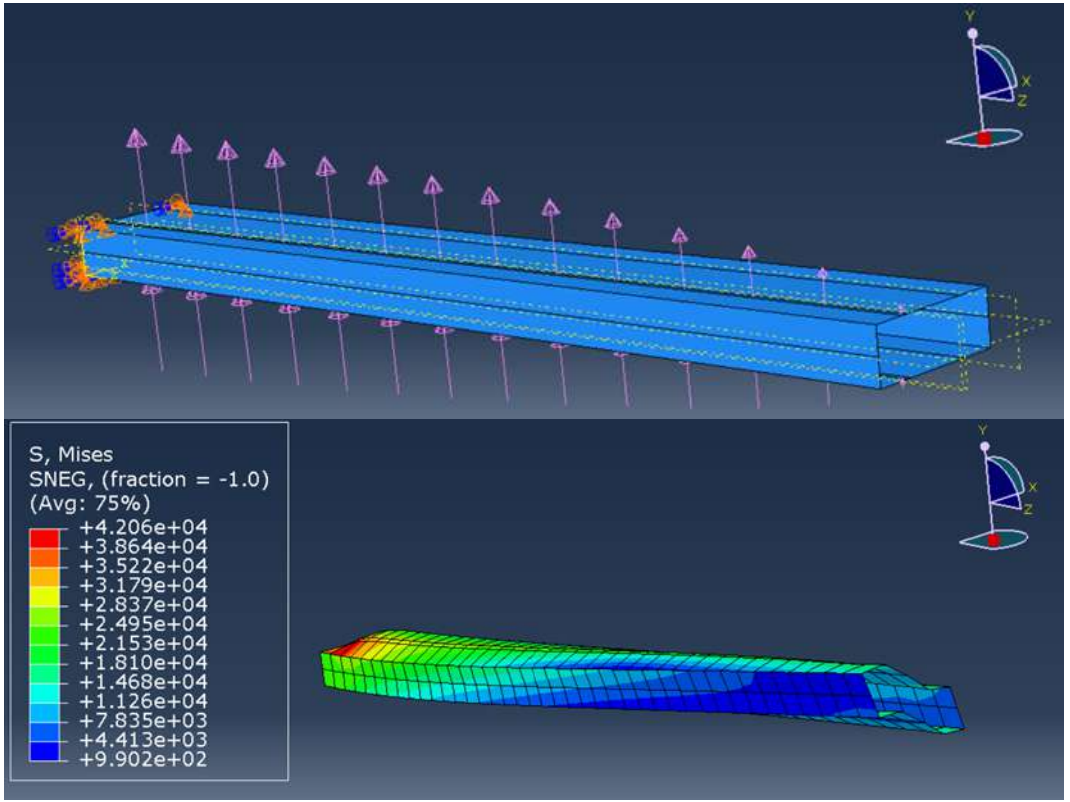


Wing Structure

- Modeled as a box beam
- Most stress at wing root, must resist fatigue and cyclic failure
- Must remain light
- Consider factor of safety

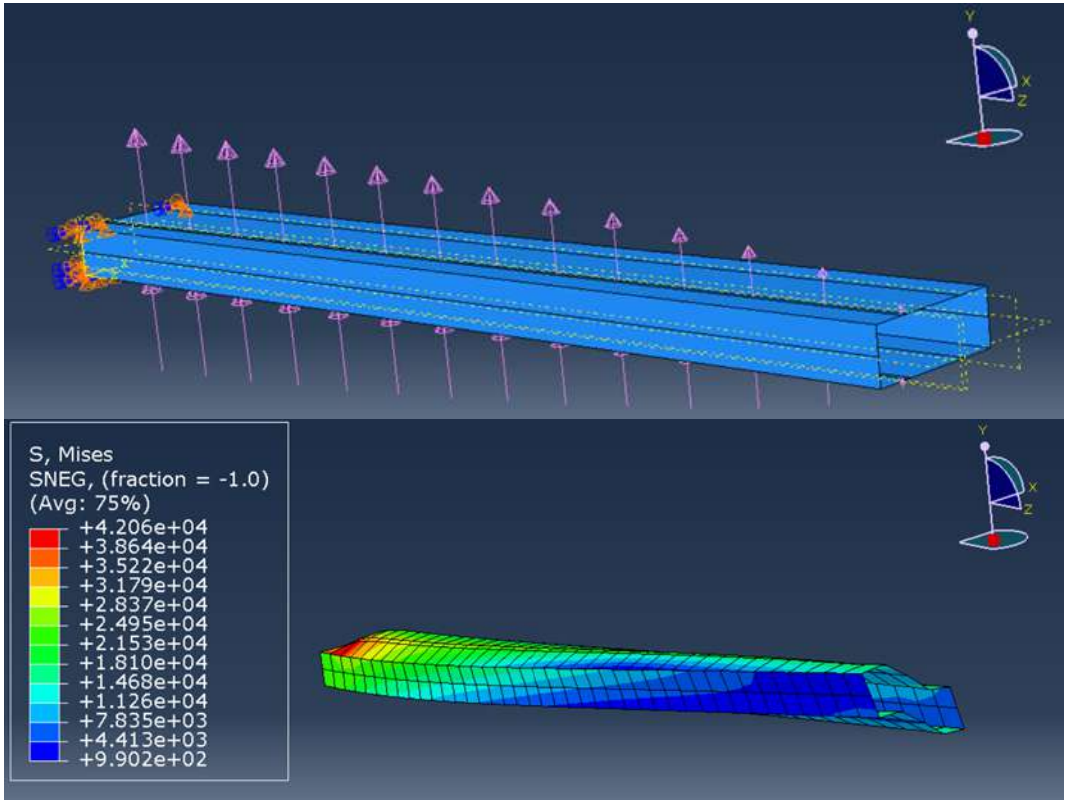
FEA Analysis

- Analyze half of the wing
- Lifting line load acting at quarter chord
  - Elliptical loading
- Use aluminum 7075-T6 as structural material
  - High strength to weight ratio



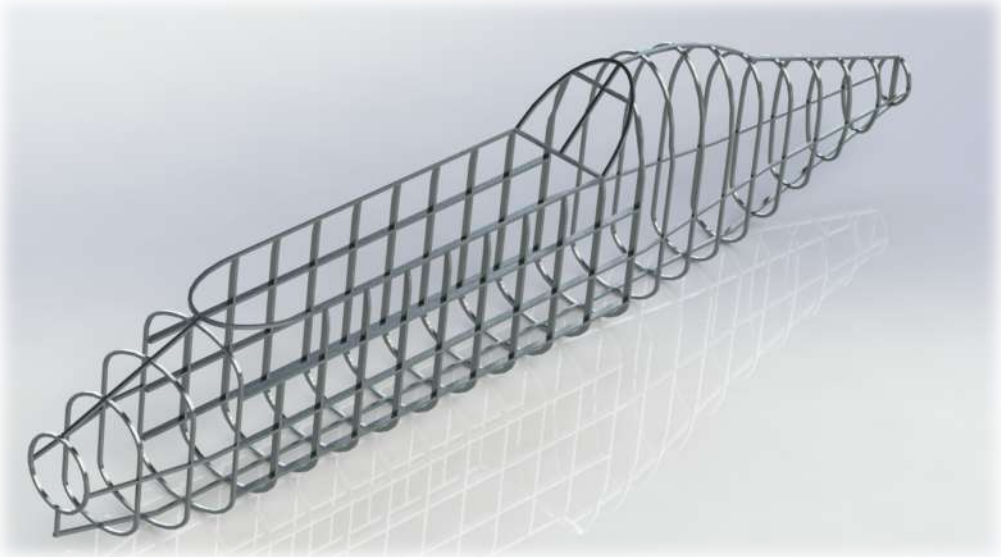
Wing Analysis

- Wall thickness
  - Top and Bottom: 0.094 in
  - Sides: 0.125 in
- Fatigue and Failure
  - Factor of safety: 1.52
  - Max. allowable crack: 0.686 in
  - 5×10^6 cycles to failure



Fuselage Structure

- Semi-monocoque
  - Easier to manufacture and repair
- 7075-T6 Aluminum
  - Great strength to weight



Materials

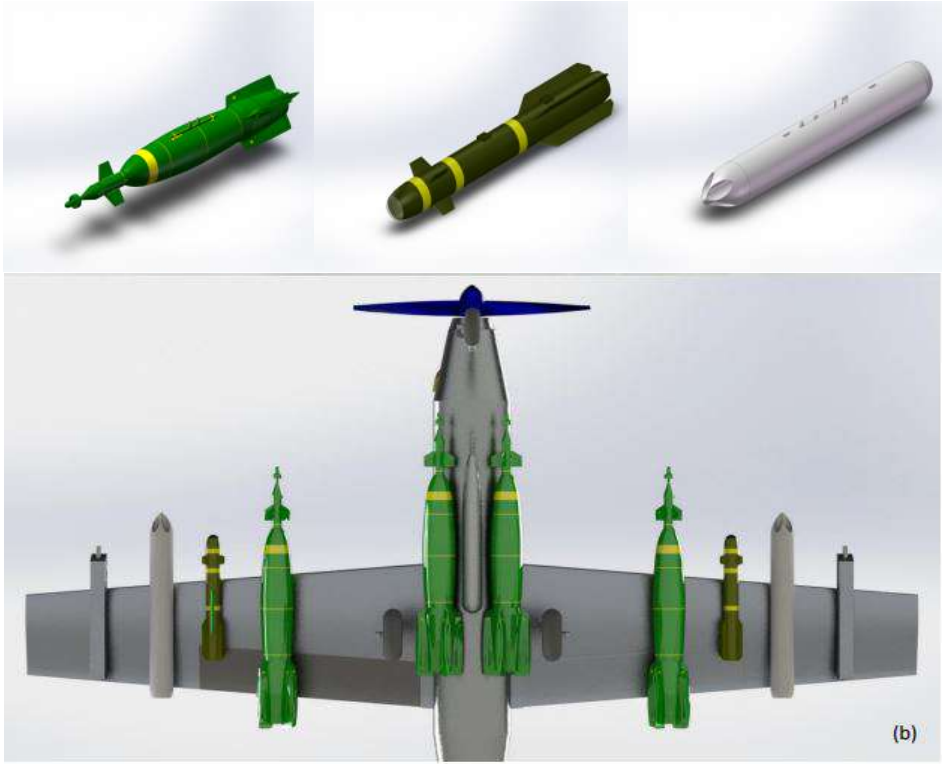
- 2024-T3 Aluminum – Skin
- 7075-T6 Aluminum – Structural
- Ti6A1 Titanium – Engine structure
- Carbon Fiber Composite – Propeller

Table XX: Common Aircraft Materials and Properties

Material	2024-T3	6061-T6	5052-T6	7075/7050/ 7010	Ti-6A1 Titanium	Carbon Fiber Composite
Young's Modulus (MSi)	10.6	9.9	10	10.3	16	75.4
Ultimate strength (tensile) (KSi)	62	45	33	72	160	550
Shearing Strength (KSi)	37	30	20	43	100	85.6
Yield Strength (tensile) (KSi)	45	35	28	64	145	467

Weapons - Payload

- Total Payload Weight: 2,704.8 lb
  - 4: GBU-49 Enhanced Paveway II 500 lb laser-guided bombs
  - 2: AGM-114 Hellfire Missiles
  - 14: GATR 2.75 in laser-guided rockets



Weapons – Integrated Guns

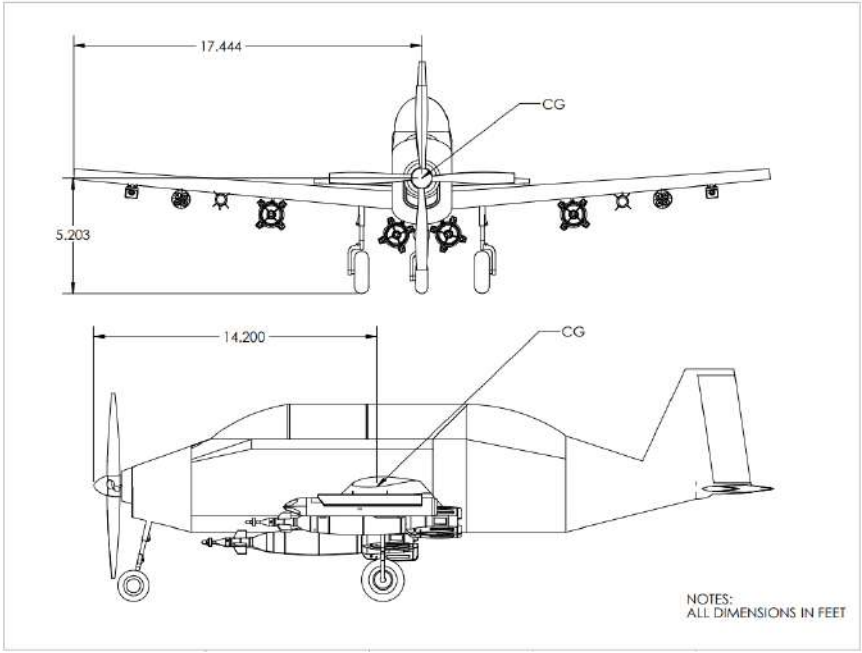
- Three guns are mounted underneath the aircraft.
- One 20 mm NC621 gun pod mounted on the aircraft's centerline.
- Two HMP-400 .50 Caliber gun pods, one mounted under each wing.

Weight Estimation

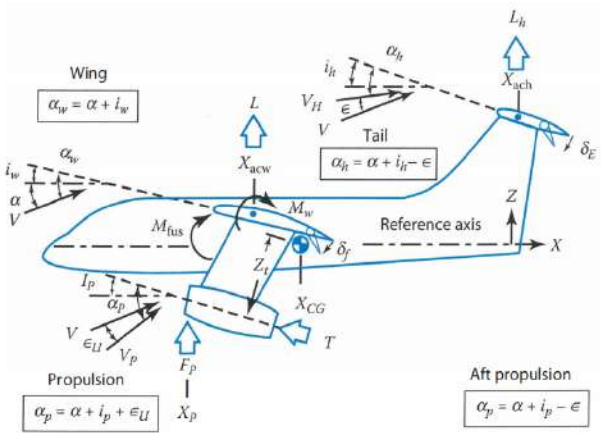
System	Weight (lb)
Propulsion	806.4
Structures	2092.4
Equipment	1560.0
Armament	3414.8
Empty weight	7873.5
Useful load	3086.3
Total weight	10959.8

Center of Gravity Estimation

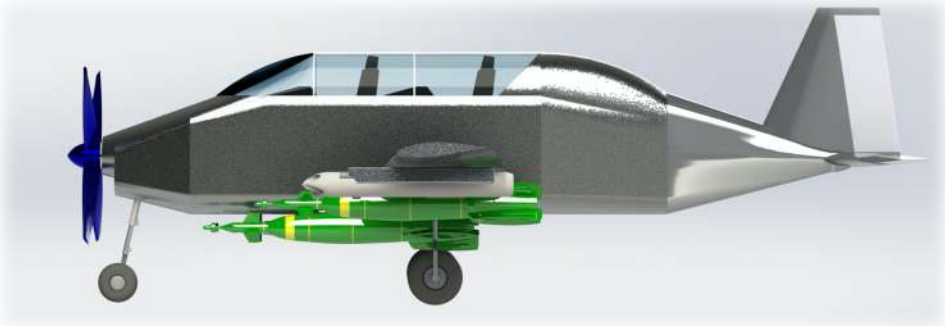
- Estimate location of each system
- X-direction: 14.200 ft
- Y-direction: 17.444 ft
- Z-direction: 5.203 ft



Longitudinal Stability

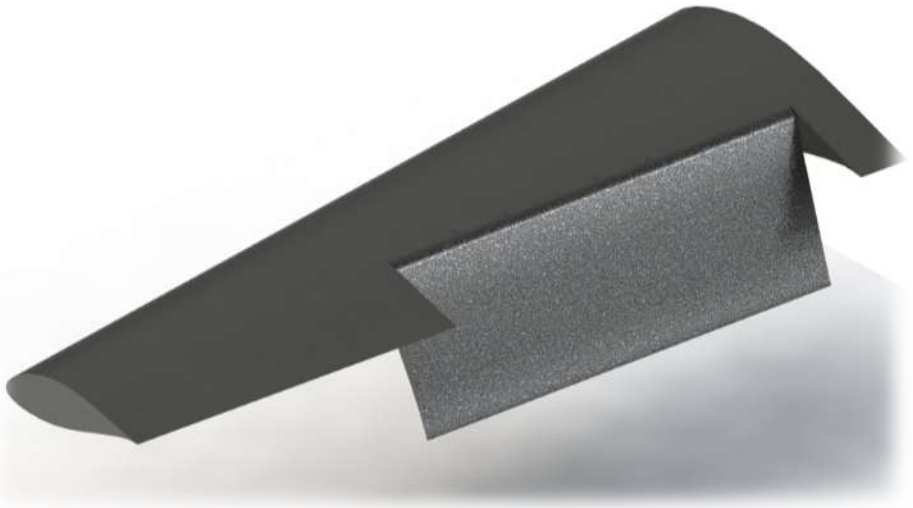


- Considered structural components:
  - Wing, horizontal stabilizer, fuselage, propeller
- $C_{m_{\alpha(empty)}} = -0.1345$
- $C_{m_{\alpha(full)}} = -0.268$
- Static margin (empty) : 0.025 ft
- Static margin (full) : 0.0499 ft



Longitudinal Stability

- $\delta_{f\,cruise} = 0°$
- $\delta_{f\,takeoff/landing} = 13.3°$

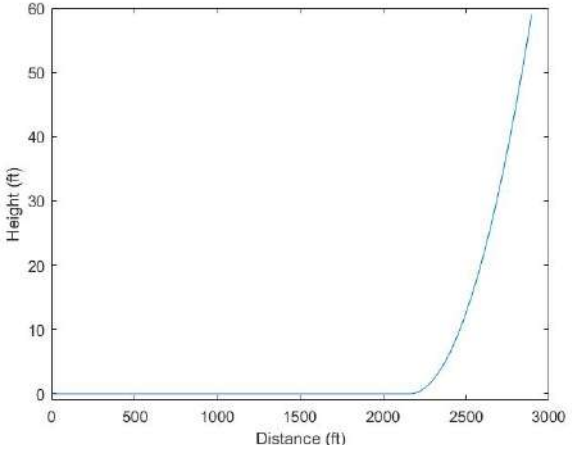


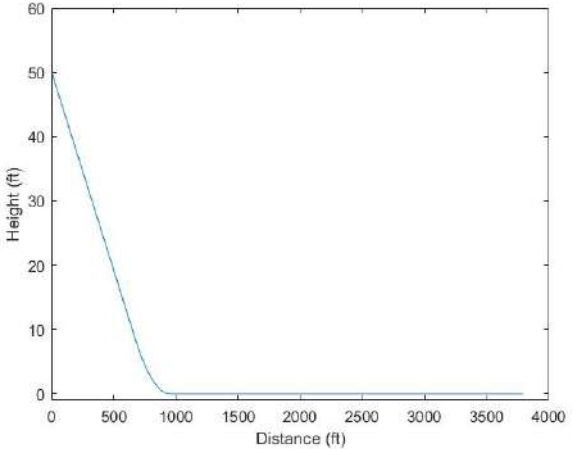
Lateral-Directional Stability

- Considered Structural Components:
  - Fuselage, Vertical Tail, Wing, Wing Dihedral
- $C_{l_\beta} = -0.138$
- $C_{n_\beta} = -0.024$
- Crosswind Landing Lateral Trim
  - $\delta_a = -15°$ and $96.64°$

Performance

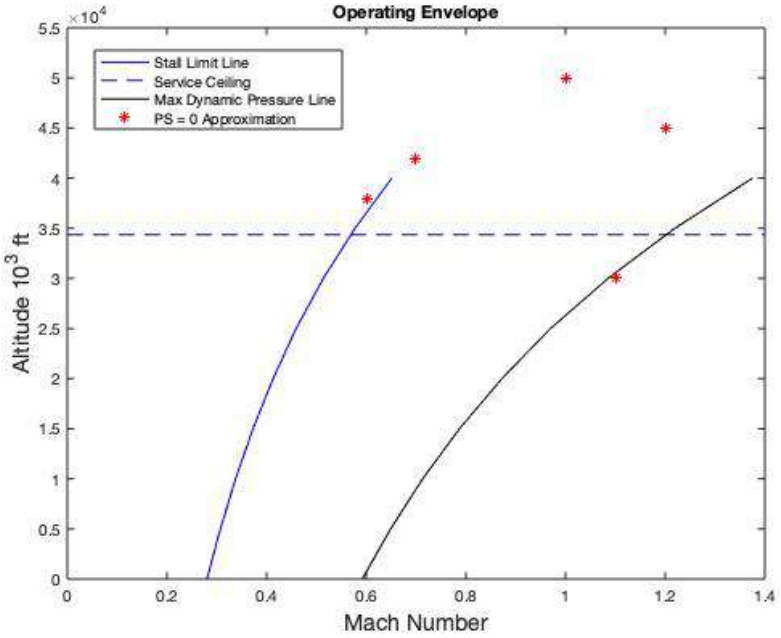
- Range: 3137.6 nm
- Endurance: 12.78 hrs
- Cruise weight fraction: 3.065
- Takeoff distance: 2901 ft
- Landing distance: 3790 ft





Performance – Operating Envelope

- Cruising speed: 322 mph (472 ft/s)
- Cruising altitude: 25,000 ft
- Service ceiling: 34,360 ft
- Stall limit and maximum dynamic pressure lines
- Specific power approximation

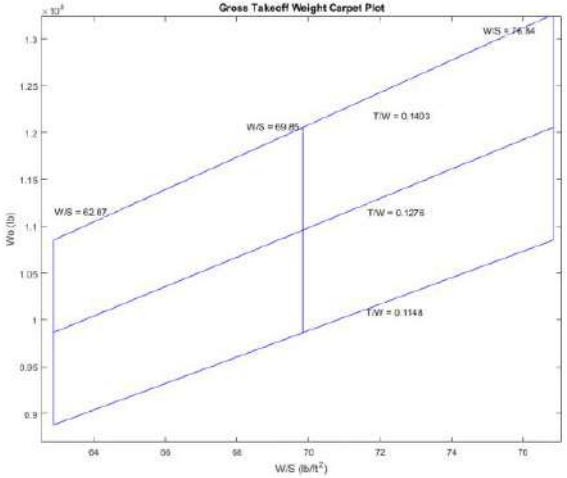


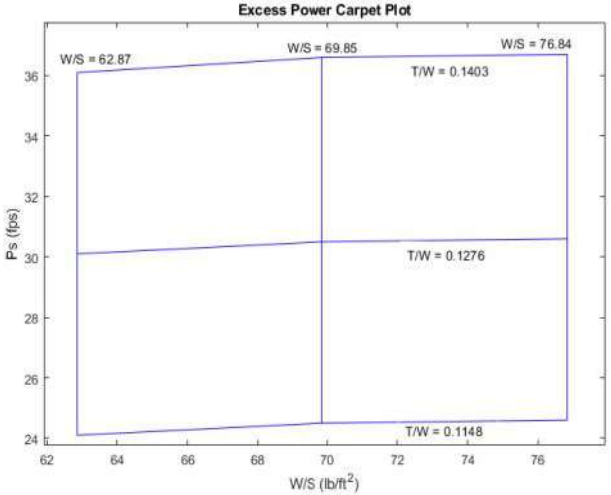
Yearly Costs

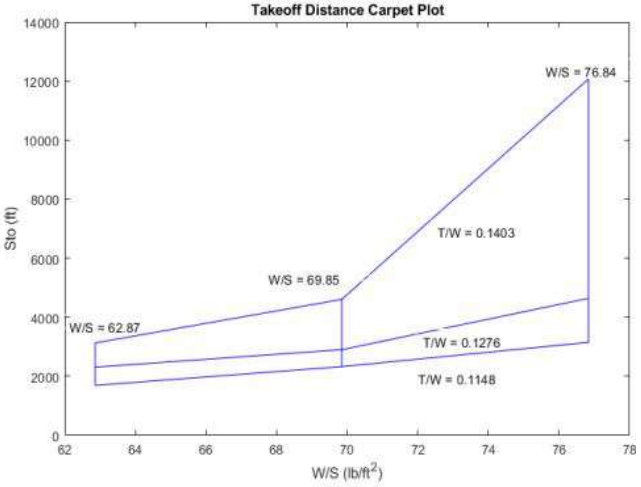
Cost	Single aircraft	50 aircraft
RDT&E/Flyaway	$13,522,000.00	$676,100,000.00
Fuel	$494,000.00	$24,700,000.00
Maintenance	$463,800.00	$23,190,000.00
Consumables	$20,700.00	$1,035,000.00
Crew Salary	$107,640.00 (Per Crew Member)	$107,640.00 (Per Crew Member)

*Each cost is over the course of one service year, totaling 1,200 flight hours.

Carpet Plots





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Questions?

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